Check List the journal of biodiversity data

LISTS OF SPECIES

Check List 12(2): 1865, 28 March 2016 doi: http://dx.doi.org/10.15560/12.2.1865
ISSN 1809-127X

Holocene crustaceans from the Tarioba shell mound, Rio das Ostras, Rio de Janeiro, Brazil

Felipe Barta Rodrigues[1*], **Michelle Rezende Duarte**[1], **Rosa Cristina Corrêa Luz de Souza**[1], **Abílio Soares-Gomes**[2] and **Edson Pereira Silva**[1]

1 Laboratório de Genética Marinha e Evolução (LGME/UFF), Universidade Federal Fluminense, Instituto de Biologia, Departamento de Biologia Marinha, Outeiro São João Batista, CEP 24.001-970, Niterói, RJ, Brazil
2 Laboratório de Ecologia de Sedimentos Marinhos (ECOSED), Universidade Federal Fluminense, Instituto de Biologia, Departamento de Biologia Marinha, Outeiro São João Batista, CEP 24.001-970, Niterói, RJ, Brazil
* Corresponding author. E-mail: felipebarta@id.uff.br

Abstract: Crustacean remains from the Tarioba shell mound (Sambaqui da Tarioba) archaeological site were investigated in order to produce a reference inventory of this taxonomic group. Information on past crustacean diversity is important for establishing baselines on biodiversity, as well as recovering paleoenvironmental information and comprehension of evolutionary change patterns for the Brazilian coast. The archaeological site was excavated by delayering the soil by artificial 10 cm sections which revealed five archaeological stratigraphic layers. A sample of mollusk shells for each of these layers was used for dating based on the C^{14} method. The results show an occupation period of 550 yr for the Tarioba shell mound, with dates ranging between 4,070 cal BP (beginning of occupation) and 3,520 cal BP (occupation ending) and record nine species of crustaceans from the shell mound. However, a reduction of biodiversity over time was found that was not statically significant. Therefore, it seems that patterns of composition, richness and distribution of crustaceans have been stable in the last 4,070 years BP.

Key words: archaeozoology; biodiversity; coastal region; hunter-gatherers; shell mounds; species' inventory; Arthropoda; Crustacea

INTRODUCTION

Shell mounds are archaeological sites found in almost all coastal areas around the world. They are recognized as artificial constructions built by prehistoric peoples (Stein 1992; DeBlasis et al. 2007; Scheel-Ybert et al. 2009; Villagran and Giannini, 2014). In Brazil, particularly in the states of Espírito Santo and Santa Catarina, there are hundreds of shell mounds that attest the human occupation of the coast between 8,000 to 1,000 years BP (before present) (DeBlasis et al. 1998, 2007; Lima et al. 2002, 2003). The large volume and the frequent concentration of human burials inside mounds led researchers to interpret their formation as building endeavors, although their function is still a matter of debate (DeBlasis et al. 1998; Villagran and Giannini 2014). Shell mounds are found near embayments, such as bays and lagoons, in the interface between marine and terrestrial, or salt- and freshwater environments (DeBlasis et al. 2007), localities which show high biotic productivity, harboring a high density and diversity of life forms.

Abundant biological remains in shell mounds indicate the use of mollusks, crustaceans, sea urchins, fishes, birds and mammals in prehistoric human culture (Stein 1992; Figuti 1993; Gaspar 2000; Lima 2000; Villagran and Giannini 2014). Furthermore, biological remains in shell mounds provide information on the diversity of flora and fauna of sites at the time of the creation of mounds from late Holocene (Fürsich 1995; Scheel-Ybert et al 2006; Lindbladh et al. 2007; Froyd and Willis 2008; Villagran and Giannini 2014). Thus, based on archaeozoological research on shell mounds, it is possible to retrieve important information on biodiversity that was subject to prehistoric human activities (Reitz and Wing 2008).

The Tarioba shell mound (Sambaqui da Tarioba) archaeological site was discovered in 1967. The first phase of excavation took place only in 1998–1999. As a result, the Sambaqui da Tarioba Museum was created, presenting an *in situ* sample of the material recovered during the excavation. Information on dating from this research record ages ranging from 3,620 to 3,440 years BP (Dias 2001). More recently, Macario et al. (2014) established a chronology of this shell mound based on dating of well-preserved shells of the bivalve *Iphigenia*

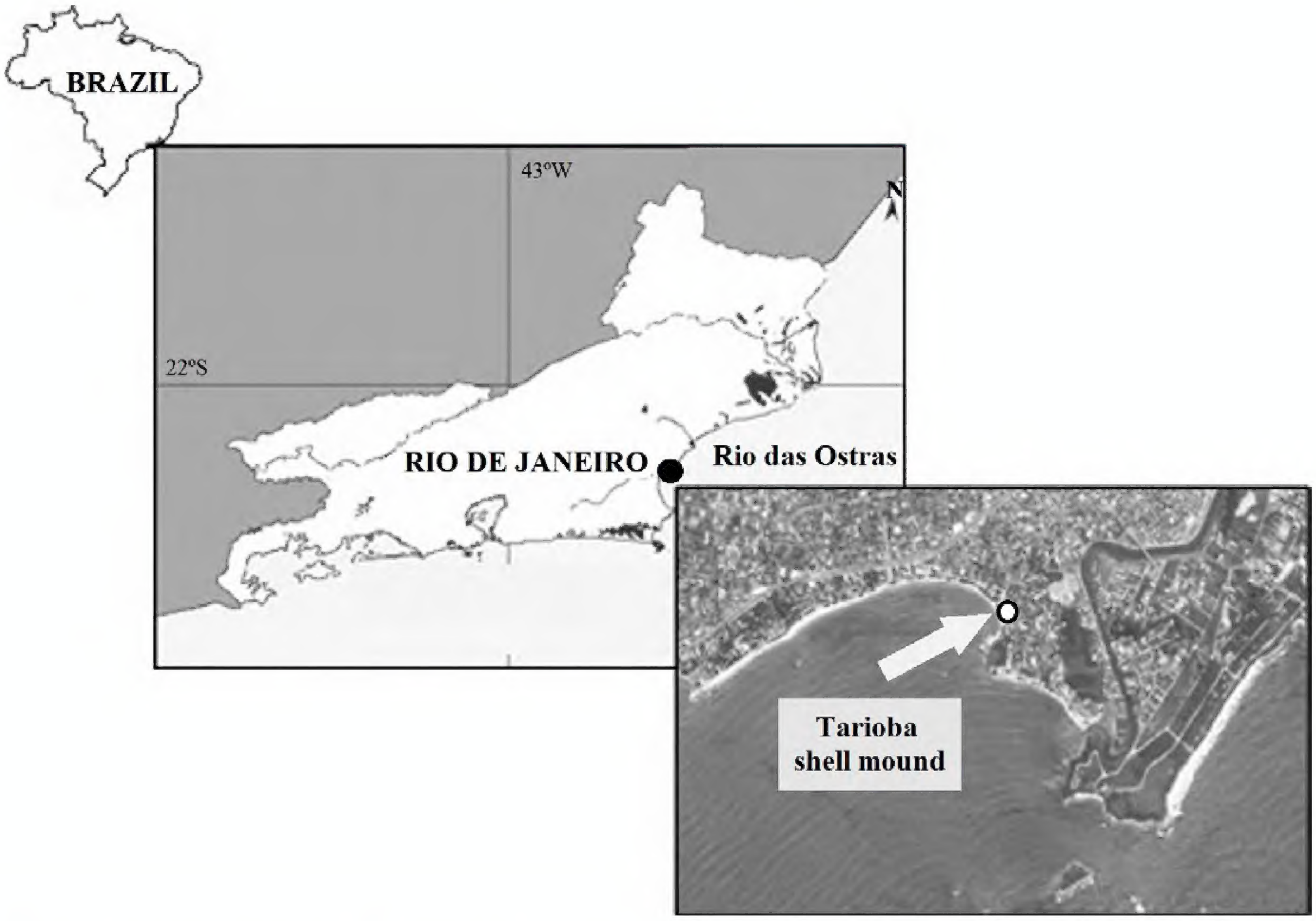

Figure 1. Location of the Tarioba shell mound, in the municipality of Rio das Ostras, state of Rio de Janeiro, Brazil (22°31′40″ S, 041°56′22″ W).

brasiliana (Lamarck, 1818) and charcoal from fireplaces in sequential layers. Radiocarbon dating analysis and a statistical model developed using OxCal software, indicate that the settlement occupation begun most probably around 3,800 cal BP and lasted for up to five centuries.

Regarding the biological diversity, the Tarioba shell mound has a malacological inventory of 47 species, including bivalves and gastropods (Souza et al. 2010). Faria and collaborators using taxonomic distinctness tests were able to demonstrate that such inventory is not statistically different from a random sample of species from that locality (Faria et al. 2014); therefore, they concluded that the Tarioba shell mound is a good repository of information on the Late Holocene biodiversity of the region.

In the present study, remains of crustaceans from the Tarioba shell mound were investigated in order to produce a reference inventory of this taxonomic group. Informaiton on past crustacean diversity is important to establish baselines on biodiversity, as well as recovering paleoenvironmental information and comprehension of evolutionary change patterns for the Brazilian coast in the last 4,000 years.

MATERIALS AND METHODS

The Tarioba shell mound is located in the municipality of Rio das Ostras, state of Rio de Janeiro, Brazil (22°31′40″ S, 041°56′22″ W) (Figure 1). All necessary permissions have been obtained from the Instituto do Patrimônio Histórico e Artístico Nacional (IPHAN) for this study, which complied with all relevant regulations (Process number: 01500.001724/2012-44, Diário Oficial da União, 30/07/2012, section one, page 20). Excavation of two different sectors (HS-A1-e and HS-B4-d) of this shell mound was performed between 20 August 2012 and 6 September, 2012. The excavation depth was 1.3 m and the material analyzed in this study corresponds to 108 sediment buckets (662.2 kg) from the HS-A1-e sector.

Delayering of the soil was done by artificial 10 cm sections which revealed five archaeological stratigraphic layers (Figure 2). The layers were sequentially labeled from 1 (L1) to 5 (L5). Sediment was collected with mason's trowel, spatula, brush, and shovel and deposited in buckets. All material was sorted, packaged, labeled and sent to the Laboratório de Genética Marinha e Evolução, Universidade Federal Fluminense, where it

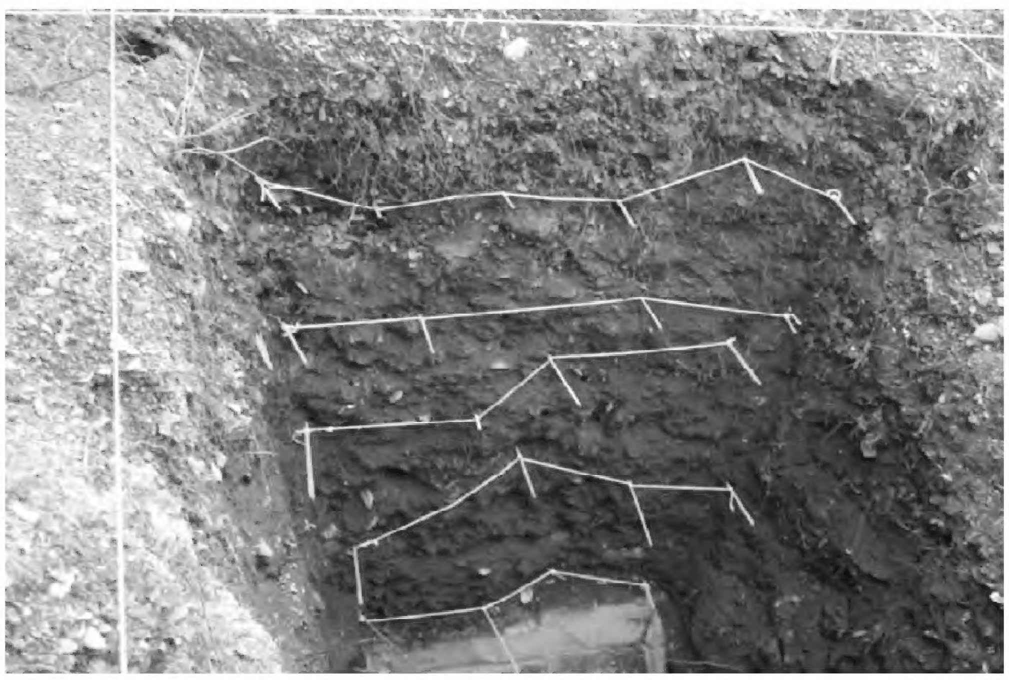

Figure 2. HS-A1-e sector of the Tarioba shell mound showing the five archaeological stratigraphic layers marked with strings.

was washed and passed through a 4 mm mesh. Remains of crustaceans were picked out from this material. Following Scheel-Ybert et al. (2006) protocol, samples were dried naturally, without the aid of ovens, in order to avoid sudden water loss which might cause an increase in fragmentation and hamper identification. The crustacean material classification was done by comparisons with the collection of decapods from the Museu de Zoologia Universidade de São Paulo. After identification, the voucher specimens were deposited in the collection of the Laboratório de Genética Marinha e Evolução (Niterói, RJ) and the remaining material will be deposited in the Instituto de Arqueologia Brasileira (IAB). Classification of the species in families was based on De Grave et al. (2009).

An accumulation curve test was performed in order to determine the minimum number of sampled bucks necessary to recover the maximum number of species per archaeological stratigraphic layer. Species richness was calculated for each archaeological stratigraphic layer dividing the number of species in the layer by the total number of species found for the shell mound. Frequency of occurrence for each species was calculated over all layers. These calculations were performed with Microsoft Office Excel 2007. To test the significance of species richness between the archaeological stratigraphic layers it was used a Kruskal-Wallis test with the software PAST 2.08 (Hammer et al. 2001).

A sample of shells of the bivalve *Iphigenia brasiliana* for each of the archaeological stratigraphic layers were taken and sent for dating based on the C^{14} method (Beta Analytic, Miami, Florida, USA) using the AMS technique (Accelerator Mass Spectrometry).

RESULTS

The accumulation curve test showed a sampling sufficiency only for L3 and L4. Crustacean remains for all layers consisted of 1,263 pieces, most of them chelae. These pieces represented nine species from eight families: *Callinectes danae* Smith, 1869 and *Callinectes sapidus*

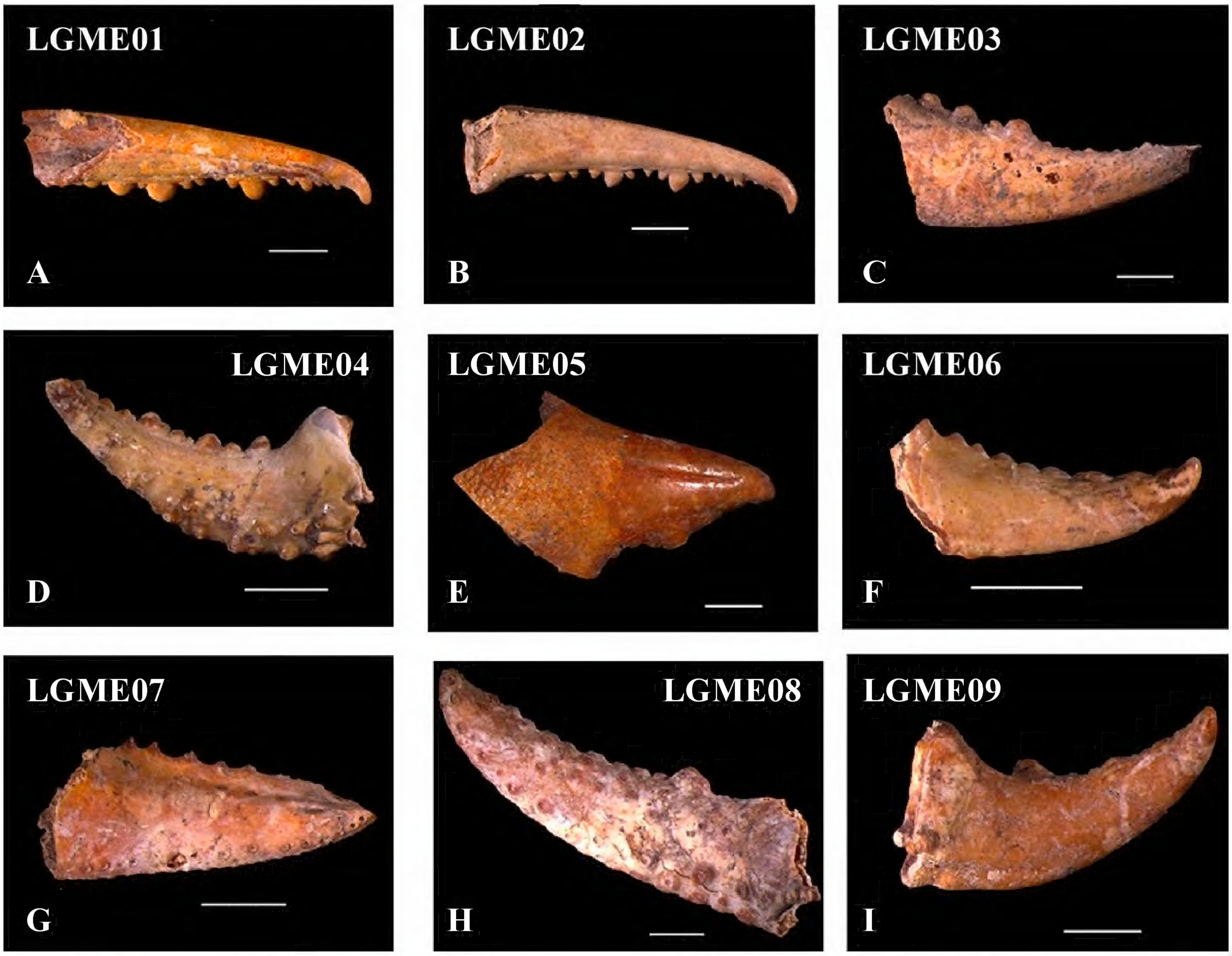

Figure 3. Voucher specimens, with morphological characters used for identification. **A:** *Callinectes danae* (elongated dactyl format. Teeth arranged in a single row, with two small followed by a larger one pattern. More pointed teeth than the Callinectes sapidus); **B:** *Callinectes sapidus* (elongated dactyl format, teeth arranged in a single row, with two small followed by a larger one pattern); **C:** *Cardisoma guanhumi* (rounded tubers, arranged in a row, the largest tuber near to the palm); **D:** *Goniopsis cruentata* (curved dactyl format, with teeth distributed in four rows); **E:** *Menippe nodifrons* (large tuber at the base, followed by other smaller tubers); **F:** *Mithrax hispidus* (curved dactyl format, teeth arranged in a single row, with the largest tooth near to the palm); **G:** *Ocypode quadrata* (small tubers arranged in four rows, it has small thorns arranged in a single row); **H:** *Ucides cordatus* (tubers arranged in three rows with other dispersed, it has thorns records); **I:** *Panopeus austrobesus* (curved dactyl format, with a large basal tooth). Scale bars = 5 mm.

Rathbun, 1869 (Portunidae); *Ocypode quadrata* (Fabricius, 1787) (Ocypodidae); *Ucides cordatus* (Linnaeus, 1763) (Ucididae); *Panopeus austrobesus* Williams, 1983 (Panopeidae); *Cardisoma guanhumi* Lattreille, 1825 (Gecarcinidae); *Menippe nodifrons* Stimpson, 1859 (Menippidae); *Goniopsis cruentata* (Latreille, 1803) (Grapsidae) and *Mithrax hispidus* (Herbst, 1790) (Majidae). Figure 3 shows vouchers specimens with their numbers and morphological characters used for species identification.

Regarding the diversity of species, Layer 1 (L1) showed the highest species richness (R_{SPP} = 1.0) while the others showed R_{SPP} = 0.88 (Table 1). The most common species were *Callinectes danae*, *Callinectes sapidus*, *Ucides cordatus*, *Cardisoma guanhumi*, *Goniopsis cruentata* and *Panopeus austrobesus* present in all archaeological layers. The species with lower frequency of occurrence was *Mithrax hispidus* (F=0.4), present only in L1 and L5 (Table 2).

The radiocarbon dating allowed predicting an occupation time for the Tarioba shell mound site which lasted 550 yr, ranging between 4,070 cal BP (beginning of occupation) and 3,520 cal BP (occupation ending). The five archaeological stratigraphic layers showed no chronological coherence (Table 1). The top layer (L1) was dated as the oldest (4,070 to 3,730 BP) and the layer L3 was the most recent (3,790 to 3,520 BP).

Comparing the species richness obtained for each archaeological stratigraphic layer it is possible to identify a decrease in species richness over time. These data could indicate that the collection of resources held by fisher-hunter-gatherers could be jeopardizing the resources or that as vestiges of building material, funerary offerings or feastings, some absences are due to careful human choices. However, the Kruskal-Wallis statistical test indicated that this difference is not significant (p = 0.9922).

Table 1. Species richness and dating for each of the archaeological stratigraphic layer sampled.

Layer	R_{spp}	Conventional Age	Calibrated Ages	Beta code
L1	1.0	3,860 ± 40 BP	4,070 to 3,730 BP	335465
L2	0.88	3,670 ± 30 BP	3,800 to 3,540 BP	335466
L3	0.88	3,660 ± 30 BP	3,790 to 3,520 BP	335467
L4	0.88	3,810 ± 30 BP	4,010 to 3,640 BP	335468
L5	0.88	3,780 ± 40 BP	3,950 to 3,630 BP	335469

Table 2. Frequency of occurrence (F) for each of the nine species recorded.

Family	Species	Layers	F
Portunidae	*Callinectes danae*	1, 2, 3, 4, 5	1.0
	Callinectes sapidus	1, 2, 3, 4, 5	1.0
Gecarcinidae	*Cardisoma guanhumi*	1, 2, 3, 4, 5	1.0
Grapsidae	*Goniopsis cruentata*	1, 2, 3, 4, 5	1.0
Menippidae	*Menippe nodifrons*	1, 2, 3, 4, 5	1.0
Majidae	*Mithrax hispidus*	1, 5	0.4
Ocypodidae	*Ocypode quadrata*	1, 2, 3, 4	0.8
Ucididae	*Ucides cordatus*	1, 2, 3, 4, 5	1.0
Panopeidae	*Panopeus austrobesus*	1, 2, 3, 4, 5	1.0

DISCUSSION

A peculiar and quite evident feature of archaeological sites is the fact that they are artificial accumulation of organisms; therefore, the set of organisms found in these sites represents a biased sampling of the natural biological communities. Factors as diverse as culture, preferences, technical level, food taboos and the way materials were discarded and utilized certainly played a relevant role on the composition of the fauna found in shell mounds. Another consideration is the differences of preservation potential of species in these sites (Prummel and Heinrich 2005). However, a recent study of mollusks from excavation discards at the Tarioba shell mound site revealed that the malacological taxonomic diversity recovered for this shell mound was representative of the present day mollusk diversity in the coast of Rio de Janeiro state. This result was obtained by means of taxonomic distinctness (AvTD) and variation in taxonomic distinctness (VarTD) tests (Faria et al. 2014).

Results obtained from Macario et al. (2014) allowed for predicting an occupation time not exceeding 500 yr for this site, with dates ranging between 3,818 and 3,160 BP, quite similar to the results found here and different from that found in dating carried out by Dias (2001). The chronological irregularity of the five archaeological stratigraphic layers was also found by Macario et al. (2014). Shell mounds are human constructions; therefore, reworking of their building material is possible and that can explain the fact that layers are not arranged chronologically. Villagran and Giannini (2014) in using shell mounds as environmental proxies recognized evidences of shell mounds being built after reworking of debris deposited close by and natural sediments from the surroundings. Moreover, the Tarioba shell mound site has been being destroyed by intense urbanization since its discovery in 1967. During the time of its first excavation, which took place in 1998–1999, two-thirds of the site had already been destroyed. Therefore, besides the reworking of their building material during their construction it is also not possible to disregard the effects of recent human activities in the area due to urbanization.

In conclusion, the data obtained allowed predicting an occupation time of 550 yr for the Tarioba shell mound, with dates ranging between 4,070 cal BP (start of occupation) and 3,520 cal BP (end of occupation) and a record of nine species of crustaceans. An apparent reduction of crustacean diversity over time was not statically significant and points to no evolution of the patterns of composition, richness and distribution of crustacean biodiversity in the Rio das Ostras region in the last 4,070 years BP.

ACKNOWLEDGEMENTS

This work was financially supported by Carlos Chagas Filho Foundation for Scientific Research in Rio de

Janeiro (FAPERJ, E-26/110.037/2011). RCCL Souza is supported by a CAPES-PNPD post-doctoral scholarship (Process number 007340/2011-09). This research was developed in the area of the Museu do Sambaqui da Tarioba, Rio das Ostras, RJ, Brazil established by researchers from Instituto de Arqueologia Brasileira under coordination of Ondemar Dias and Paulo Seda in agreement with Fundação Casa de Cultura from Rio das Ostras. We would like to acknowledge the invaluable expertise of Dr. Marcos D. S. Tavares (Museu de Zoologia, Universidade de São Paulo) in species identification. Finally, we acknowledge the help of Mariana Lopes and Orangel Aguilera in the establishing of the species list.

LITERATURE CITED

DeBlasis P., S.K. Fish, M.D. Gaspar and P.R. Fish. 1998. Some references for the discussion of complexity among the sambaqui moundbuilders from the southern shores of Brazil. Revista de Arqueologia Americana 15: 75–105.

DeBlasis P., A. Kneip, R. Scheel-Ybert, P.C. Giannini and M.D. Gaspar. 2007. Sambaquis e paisagem: dinâmica natural e arqueologia regional no litoral do sul do Brasil. Arqueologia Suramericana 3: 29–61.

De Grave S., N.D. Pentcheff, S.T. Ahyong, T. Chan, K.A. Crandall, P.C. Dworschak, D.L, Felder, R.M. Feldmann, C.H.J.M. Fransen, L.Y.D. Goulding, R. Lemaitre, M.E.Y. Low, J.W. Martin, P.K.L. Ng, C.E. Schweitzer, S.H. Tan, D. Tshudy and R. Wetzer. 2009. A classification of living and fossil genera of decapod crustaceans. Raffles Bulletin of Zoology 21: 1–109.

Dias, O. 2001. O Sambaqui da Tarioba; pp. 37–50, in: O. Dias, J. Decco and M.M. Fróes. (org.). A pré-história de Rio das Ostras: sítio arqueológico sambaqui da Tarioba. Rio das Ostras: Fundação Rio das Ostras de Coltura: Inside.

Faria, R.G.S., E.P. Silva and R.C.C.L. Souza. 2014. Biodiversity of marine molluscs from Sambaqui da Tarioba, Rio das Ostras, Rio de Janeiro (Brazil). Revista Chilena de Antropología 29: 49–54. doi: 10.5354/0719-1472.2014.36205

Figuti, L. 1993. O homem pré-histórico, o molusco e o sambaqui. Revista do Museu de Arqueologia e Etnologia USP 3: 67–80. http://biblat.unam.mx/pt/revista/revista-do- museu-de-arqueologia-e-etnologia/articulo/o-homem-pre-historico-o-molusco-e-o-sambaqui-consideracoes-sobre-a-subsistencia-dos-povos-sambaquieiros

Froyd, C.A. and K.J. Willis. 2008. Emerging issues in biodiversity and conservation management: the need for a palaeoecological perspective. Quaternary Science Reviews 27: 1723–1732. doi: 10.1016/j.quascirev.2008.06.006

Fürsich, F.T. 1995. Approaches to paleoenvironmental reconstructions. Geobios 28: 183–195. doi: 10.1016/S0016-6995(95)80165-0

Gaspar, M.D. 2000. Sambaqui: arqueologia do litoral Brasileiro. Rio de Janeiro: Jorge Zahar. 89 pp.

Hammer, O., D.A.T. Harper and P.D. Ryan. 2001. PAST: Paleontological Statistics Software Package for Education and Data Analysis. Palaeontologia Electronica 4(1): 1–9. http://palaeo-electronica.org/2001_1/past/past.pdf

Lima, T.A. 2000. Em busca dos frutos do mar: os pescadores-coletores do litoral centro-sul do Brasil. Revista da Universidade de São Paulo 44: 270–327. doi: 10.11606/issn.2316-9036.v0i44p270-327

Lima, T.A., K.D. Macário, R.M. Anjos, P.R.S. Gomes, M.M. Coimbra and E. Elmore. 2002. The antiquity of the prehistoric settlement of the central-south Brazilian coast. Radiocarbon 44(3): 733–738. http://journals.uair.arizona.edu/index.php/radiocarbon/article/view/4072/3497

Lima, T.A., K.D. Macário, R.M. Anjos, P.R.S. Gomes, M.M. Coimbra and E. Elmore. 2003. AMS dating of early shellmounds of the southeastern Brazilian coast. Brazilian Journal of Physics 33(2): 276–79. doi: 10.1590/S0103-97332003000200020

Lindbladh, M., J. Brunet, G. Hannon, M. Niklasson, P. Eliasson, G. Eriksson and A. Ekstrand. 2007. Forest history as a basis for ecosystem restoration: a multidisciplinary case study in a south Swedish temperate landscape. Restoration Ecology 15: 284–295. doi: 10.1111/j.1526-100X.2007.00211.x

Macário, K.D., R.C.C.L. Souza, D.C. Trindade, J. Decco, T.A. Lima, O.A. Aguilera, A.N. Marques, E.Q. Alves, F.M. Oliveira, I.S. Chanca, C. Carvalho, R.M. Anjos, F.C. Pamplona and E.P. Silva. 2014. Chronological model of a Brazilian Holocene shellmound (Sambaqui da Tarioba, Rio de Janeiro, Brazil). Radiocarbon 56: 489–499. doi: 10.2458/56.16954

Prummel, W. and D. Heinrich. 2005. Archaeological evidence of former occurrence and changes in fishes, amphibians, birds, mammals and molluscs in the Wadden Sea area. Helgoland Marine Research 49: 55–70. doi: 10.1007/s10152-004-0207-1

Reitz, E.J. and E.S. Wing. 2008. Zooarchaeology. Cambridge: Cambridge University Press. 455 pp.

Scheel-Ybert, R., D. Klökler, M.D. Gaspar and L. Figuti. 2006. Proposta de amostragem padronizada para macro-vestígios bioarqueológicos: antracologia, arqueobotânica, zooarqueologia. Revista do Museu de Arqueologia e Etnologia USP 15–16: 139–163. http://www.nptbr.mae.usp.br/wp-content/uploads/2013/05/3_RitaScheel-Ybertetal1.pdf

Scheel-Ybert, R., S. Eggers, V. Wesolowski, C.C. Petronilho, C.H. Boyadjian, M.D. Gaspar, M. Barbosa-Guimarães, M.C. Tenório and P. DeBlasis. 2009. Subsistence and lifeway of coastal Brazilian moundbuilders. Treballs d'Etnoarqueologia 7: 37–53.

Souza, R.C.C.L, D.C. Trindade, J. Decco, T.A. Lima and E.P. Silva. 2010. Archaeozoology of marine mollusks from Sambaqui da Tarioba, Rio das Ostras, Rio de Janeiro, Brazil. Zoologia 27: 363–371. doi: 10.1590/S1984-46702010000300007

Stein, J.K. 1992. The analysis of shell middens; pp. 1–24, in: J.K. Stein (ed.). Deciphering a shell midden. San Diego: Academic Press.

Villagran, X.S. and P.C.F. Giannini. 2014. Shell mounds as environmental proxies on the southern coast of Brazil. The Holocene 24(8): 1009–1016. doi: 10.1177/0959683614534743

Author contributions: RCCLS work in the excavation of the "Sambaqui da Tarioba"; FBR did the bench work; MRD, FBR and EPS made the analysis; FBR, MRD, ASG, RCCLS and EPS wrote the text.

Received: 3 July 2015
Accepted: 3 March 2016
Academic editor: Jesser Fidelis de Souza Filho